METHOD OF CONDUCTING

EXTENSIVE SURVEYS OF MOUNTAIN PINE BEETLE INFESTATIONS

IN THE NORTHERN ROCKY MOUNTAIN REGION

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Extensive forest-insect surveys are now a part of the regular duties of many forest officers and the need for detailed instructions as to their proper conduct is recognized. This has prompted the preparation of the following instructions in the hope that they will prove to be of assistance in the execution of such projects. The need for standardized and efficient performance in conducting forest-insect surveys can not be over-emphasized, as it is from these data that the results of control operations are ascertained and future plans of control established. It is therefore essential that such projects be carefully planned and performed if the best results are to follow.

In determining the status of infestations on small units it is often possible to survey a large percentage of the total area. When large areas are infested, the necessary information can only be secured from representative samples, which are indicative of the entire unit under consideration. The efficiency of such surveys depends upon the fairness of the samples selected and the accuracy of the acreage figure to which the data from the samples are to be applied.

There are several methods for determining the status of an insect infestation but unless a uniform plan is followed, important data are invariably neglected and a just comparison of conditions within different forests, as well as different areas within the same forest, becomes impossible. In these instructions the writer desires to explain the method used by the Bureau of Entomology in conducting surveys of bark-beetle infestations [illegible], and to recommend that it be adopted as a standard practice by all Forest Service regions concerned. During the past few years this method has been subjected to severe tests, by having the estimates balanced against number of trees actually treated, and found to be sufficiently accurate to satisfy all demands. Extensive surveys of this character can not be expected to record the actual number of infested trees for each small drainage, but when applied to a larger unit the errors are compensated and the total figures found to be adequate.

In the sampling of areas, Bureau officers are strongly of the opinion that strips are more efficient than sample plots. Though these two systems perhaps offer the same mechanical possibilities, strips are not only easier to execute but permit the coverage of a much larger

acreage. With small plots close together (1/5 acre every 2 chains) there should be no difference in the quality of the data secured by these two methods. However, plots taken at greater intervals are not considered as giving as accurate a cross-section of a scattered infestation as is secured from a sample strip, and there is no question but that greater acreages can be covered by the latter method.

LOCATION OF SAMPLE STRIP

Before discussing this important phase of bark-beetle surveys, it is well to think briefly as to what constitutes a sample. *Webster* says, "A part of anything presented for inspection, or shown as evidence of the quality of the whole." It must therefore be remembered that in selecting locations for sample strips one must always bear in mind that the objective is to secure a fair sample of the area under consideration.

Though the selection of these strip locations is not a difficult task, the best judgment of the officer in charge must always be used in determining the general direction in which strips are to run and the part of the area to be sampled. It is evident that strip run along creek bottoms or the tops of ridges would not be indicative of average conditions. Likewise, strip run only in "bug timber" would not result in the securing of a fair sample, unless a proportionate amount of strip was run in non-host timber types, sagebrush, openings, etc., which would be included in the total acreage of the unit. In explanation of what is meant by a fair sample, the following situation is given. Let it be assumed that a drainage of 5,000 acres in which there are 900 acres (18%) of old burn covered with reproduction, and 850 acres (17%) of non-host material and sagebrush, is to be covered by an insect survey. To secure a representative sample of such an area, 65% of the total amount of strip, should be in the "bug timber" and the remainder, or 35% of the strip, in the areas nonproductive of infested trees. In actual practice it is impossible to work out any such detailed or accurate percentages of strip location but strips can be projected on general compass lines in such a manner that all exposures, timber types, etc., will be properly represented. "Bud Hunter psychology" results in the cruiser recording as a successful day one in which a large number of insect-infested trees are encountered. This mental reaction results from an unconscious desire to find that which is sought. So unless a definite course is previously established, the cruiser will find himself locating his sample strips in areas where the greatest number of bug trees are apt to be found. It is often said that groups of red-topped trees have a serious pull upon a compass needle. Therefore, in order that a sample strip will include the "bitter with the sweet" in reference to both

timber types and terrain, strip lines must start at a definite point, and proceed on a stated compass bearing. In covering an area, strip lines assume different patterns, depending upon the shape of the unit being surveyed and the nature of the terrain. In large areas the most common form is a long rectangle, the two sides being separated with a strip offset of one-half mile or more. With smaller areas the form may be in the shape of a triangle, square, or the gridironing of an area with short strips one-half mile or more apart. However, in all cases strip locations must be projected on general compass bearings so that the cruiser will know where he is expected to go, and to insure the traversing of such non-productive areas as sagebrush flats, reproduction and rock slides.

When surveying large, fairly solid bodies of timber, where the total acreage is known or can be determined from drainage maps, the selection of strip locations is a relatively easy task. On such areas strip lines are projected so as to secure the desired sample from all portions of the area. But with small patches of timber, where the acreage is so small and the distance between them so great as to prohibit the inclusion of the entire area in the survey, the task is not so simple. Under such circumstances it is necessary to confine the strip location to the timbered acreage of each small tract, or at best to a group of two, three or more closely connected timbered tracts. A more detailed discussion of such sampling is given under the heading, "Determination of Acreages."

Though the running of sample strip is often referred to as a mechanical procedure, may it again be stated that the strip location must always receive the careful consideration of the officer making the selection. For example, a starting point may be selected and a strip projected to extend N 45° W for a distance of four miles, then to run N 45° E for one mile, then S 45° E for four miles, and a return to the starting point by a mile run S 45° W, which appears as a fairly simple procedure. However, before such a decision is made, careful thought should be given to the location of the starting point, general compass bearings, and distances, in order that the data secured will be a representative sample of the region under consideration. Such careful thought can not be supplanted by prescribed rules, as each area presents an individual problem requiring careful study for its proper solution. There are, however, a few rules relative to strip location which one should bear in mind, as they are applicable for all areas:

1. Strip lines must not be projected along trails, ridges, or streams.

2. Strip lines should be projected perpendicular and not parallel to the course of the drainage being covered. This rule can not be followed in connection with the small side-streams or draws associated with the main drainage being covered. In extending strip

lines across a drainage a sample of different elevations, exposures, and timber types is secured.

3. Strips may run along section lines if such a compass bearing gives the desired sample.

4. Strips can extend from a selected starting point in cardinal directions or angles as the terrain may demand. The direction of the strip should be selected and plotted upon the cruiser's map prior to the start of each day's work, and only under very unforeseen conditions (see Item #6) should departures be made from it.

5. Strip should be planned so as to eliminate long walks to starting points, or back to camp at the close of the day's work. Strip can be extended in any geometric pattern best suited to the requirements of the area and still return the cruiser to the starting point, or to some place where he can be met with transportation.

6. Where impassable swamps, lakes, rock slides, cliffs, etc., are encountered, offsets can be made so as to return to the original course. In making such offsets, only the distance parallel to the general course being followed should be recorded as the distance traveled, and all infested trees encountered while making this offset are disregarded, as it is evident that none would have been encountered on the original course in the swamp, lake, or rock slide.

WIDTH OF SAMPLE STRIP

It has been determined that in the survey of mountain pine beetle infestations in lodgepole and white pine stands a strip one chain (66 feet) in width is all that one man can effectively examine. This width has been found to be the most effective as it permits the cruiser to follow a center line and spot infested trees on his strip with a minimum amount of side travel. Trees on the border of the one-chain strip or surrounded with brush require more careful observation, which is especially true in white pine stands.

COMPASS LINES

Though strips are extended on compass lines, the expression general compass bearing has been used. A compass is required to keep the cruiser upon his course, however, for insect surveys a positive

compass course is not necessary. In explanation, if a sample strip is projected on a bearing of N 30° W, it is but the direction selected by the responsible officer as being the one which in his judgment would provide the truest sample. The general course may be entirely correct, but the actual bearing is only an arbitrary selection. Therefore, though the general course must be adhered to, it is unnecessary to accurately follow the stated bearing, as too much time is required for such close work with no advantage accruing. Long compass shots, utilizing the angle of shadows from tree trunks, or keeping the sun in definite positions, will provide a sufficiently accurate course. In following such a procedure what actually happens is that the departures which a cruiser makes from his stated compass bearing are usually compensatory and a 4- or 5-mile strip will usually terminate rather close to the prescribed point. If too much attention is paid to the compass line, the amount of territory which a man can cover in one day will be materially reduced. By eliminating this unnecessary effort, the amount of strip will not only be increased but better data will be secured. A standard Forest Service staff compass is not necessary for strip surveys and its use is not recommended. A small 2-1/2"- or 3" -needle box compass is sufficiently accurate and a great deal faster. If too much attention is given to the compass line, the recording of infested trees is apt to be slighted and the missing of only a few trees on a strip will often mean a marked change in the final figures.

The amount of strip which one man can run in a day depends upon the nature of the terrain being covered and it is difficult to attempt to prescribe a standard output. Over a period of years survey crews under the supervision of the Bureau of Entomology have averaged approximately four miles in white pine types and nine miles in lodgepole per effective man-day.

OPERATION OR MECHANICS OF RUNNING SAMPLE STRIP

The equipment necessary for each cruiser to have on extensive insect surveys is a box compass, two tally registers, strip-sheet forms, pencils, map of area, and a full realization of the importance of the task. Cruisers must be able to pace distances accurately over rough terrain--an ability rather easy to acquire. When one has never paced distances, the first requirement is to determine how many double paces are necessary to cover a distance of 66 feet, or one chain, when traveling at a natural gait. This number will vary from eleven to thirteen. It must always be remembered that only horizontal distances are measured, therefore the distance traveled on slopes must be adjusted to conform to this requirement. Over very rough terrain, it is often necessary to estimate the number of double paces required to cover short distances, or to take three or even four steps for a double pace. A cruiser should check his pacing

at frequent intervals, especially over long distances. In surveyed country one should try to check each time a section is crossed in a cardinal direction. A tally register is used to record the number of double paces. With a little practice the recording of one's paces becomes automatic, for the tally register will be depressed with each swing of the hand in which it is carried, or as the right or left foot strikes the ground. As stated, this procedure soon becomes automatic, and leaves the cruiser's mind free to look for "bug trees", his eyes moving from side to side. The use of tally registers for the recording of paces eliminates the mistakes which occur when one attempts to count paces and look for "bug trees" at the same time. The second tally register is used to record the number of newly attacked trees located on strip.

In lodgepole pine stands the best results are secured by each cruiser working alone. The cruiser runs his strip along the prescribed compass line, paces the distance, and counts the newly attacked trees on a strip one chain in width. With the steep slopes and heavy underbrush encountered in white pine forests, the task of pacing and running even a general compass line becomes a more difficult task than in lodgepole pine. Furthermore, these forests are often so dark, and the external evidence of insect attack so very slight, that it is necessary to examine each white pine tree very closely. In such areas it has been rather definitely demonstrated that a two-man crew gives the most efficient results. With such an organization one man runs the compass, paces and locates all bug trees on a strip one chain in width. The second man covers an additional strip one chain in width along side of and parallel to the course of the compassman. The advantage of this plan is primarily the psychological effect of two men working together over a very difficult terrain which relieves the monotony of the work and permits the changing of compass men at the end of every mile.

On the strip sheets used in connection with these surveys, the number of newly attacked trees should be recorded for every ten chains of lineal distance covered. This plan gives the general location of the infested trees, and the data secured can then be subsequently plotted upon a map to show the areas of heaviest infestation. Whenever available, a large scale map will be found best suited for this purpose. When no new attacks are encountered, no records need be made, and often a cruiser can go for a mile or more without making an entry upon the form. However, after traversing such an area, when infested trees are located the nonproductive portion of the strip should be recorded and the infested trees allotted to the ten chains of strip where they were found.

On the strip sheet there is a column for "Remarks". In this space a record should be kept as to the character of the timber being covered, sagebrush, burns, openings, reproduction, or mature timber. In recording the number of trees attacked for each ten chains, the number of different hosts, i.e., white bark pine and lodgepole pine, should be recorded separately.

There is often a tendency to count red-topped trees (attacks of the previous season) in connection with the newly attacked trees so as to secure a comparison between the losses of the two seasons. This is not a good practice and should be discontinued. It has been rather definitely proved that one can not count red tops, requiring crown observations, and new attacks, which must be examined at the base, during the same operation without a considerable amount of error. Furthermore, redtop counts are not reliable as it is difficult to determine the year in which they were attacked.

At the close of the day's work each cruiser should summarize his strip sheets and turn them over to the chief of party, who in turn summarizes all sheets for the day, and allocates them to the unit to which they apply. Each day's work should be summarized so as to show the number of miles and chains covered, number of acres, total number of new attacks, and average number of new attacks per strip acre. Each cruiser should also plot his actual strip upon the field map, as some departures may have been necessary from the planned course. In plotting actual strip, different colored inks or pencils can be used, and if the field map is of a sufficiently large scale, the number of infested trees recorded for every ten chains can be marked by the side of the strip line. When all of the survey sheets for each unit have been summarized, the average number of new attacks per acre is then applied to the total acreage of the area or unit covered.

In preparation for bark-beetle surveys the chief of party should have a carefully thought out plan of operation, showing camp locations, time to be spent in each camp, location of strip lines, etc. Such a plan will produce a better quality of data, eliminate moves and unnecessary duplication of strips, and prevent confusion in the unforeseen absence of the chief of party.

ACREAGES OF AREAS SURVEYED

The preceding discussion has been devoted to the proper method of sampling an infested area. Such samples provide an index as to the intensity of the infestation or the average number of trees per acre. To obtain a estimate of the number of infested trees on an area, the total acreage must be known. Acreage figures should be fairly accurate or

marked errors are bound to occur in the estimated total.

When large areas of several thousand acres or entire drainages are considered, the acreage can be determined through the use of a planimeter if accurate maps are available. If a planimeter is not available, a fair estimate of the acreage can be secured by counting the number of sections, or smaller blocksof a known area. However, with very small units, consisting of a part of one or more sections, the task is more difficult. Usually the available maps are of such small scale that the area can not be outlined sufficiently close to permit a computation of the acreage. Therefore, strip locations must be so planned as to provide data from which the acreage can be computed. Such data can best be secured from a strip which is projected on a zigzag course with a change in bearing each time the edge of the timbered area is reached. Such data can be subsequently plotted on a fairly large scale which will show the boundaries of the area in sufficient detail to provide a satisfactory acreage figure. If desired, map sheets, a rule and protractor can be carried and the course and boundaries plotted in the field. Though requiring additional time to construct these sketch maps in the field, better results will follow, as more data is available. When taking strip data with the idea of subsequently constructing a map, the location of all important topographical features such as ridges, streams, trails, etc., should be shown on each strip line. When these large-scale sketch maps are completed, the total acreage can be determined quickly through the use of a planimeter. Though all situations require individual solutions, it must be born in mind that insect surveys must be productive of two important items. These two items are the intensity of the infestation, or the number of infested trees per acre, and the total acreage of the area under consideration.

PERCENT OF AREA TO BE COVERED BY SURVEY

No definite rule can be given as to the percentage of an infested area which should be covered during an insect survey. Theoretically, the larger the sample the more accurate the data, which is true up to a certain point. When small areas are surveyed, a larger portion must be covered than for large units to secure an accurate estimate of the number of infested trees. Light infestations also require a larger sample than do heavy ones if accuracy is desired. However, what seems to actually determine the percentage to be covered is the magnitude of the task and the man power available. With small units varying from fifty to several hundred acres, it is necessary to cover from 8 to 15 percent of the total area to secure dependable data. Large units involving thousands of acres do not require such a large sample to assure accuracy,

as departures usually compensate each other. In surveying large stands of lodgepole pine, the minimum size of the sample should not be less than 1-1/4 percent, which is an average of a one-chain strip through each section. In white pine stands, as there are fewer trees per acre with a correspondingly lighter infestation, a larger (4-6%) sample is required.

SPOTTING OF INFESTED TREES

As extensive surveys of mountain pine beetle infestations must immediately follow the main period of attack, which is in July and early August, there is practically no foliage discoloration of the infested trees. Therefore, in locating newly attacked trees it is necessary to depend entirely upon the pitch tubes on the bole and the boring dust at the base. Though in most cases these external signs of infestation are easy to see, there are times when the presence of an attack can be determined only by a very close examination. With very heavy attacksthe pitch tubes are small or lacking entirely, and the boring dust is often obscured by grass or underbrush. The condition of the light is an important factor in the location of infested trees, for if one is pacing into the sun, it is extremely difficult to spot these external signs of attack and extra precaution must be exercised. The dense canopies of white pine stands produce rather dark forests and necessitates close examination of all trees.

All newly attacked trees are recorded as new attacks regardless of the severity of the attacks on the individual tree. Though some of the light attacks, evidenced by large pitch tubes, may prove to be "pitched out" attacks before spring, this possibility is disregarded. These potentially extra trees compensate for trees which may be missed, such as attacks occurring subsequent to the survey, and one-sided attacks on the opposite side of the tree from the observer.

REPORTING OF INSECT-SURVEY DATA

In submitting a report on the results of insect surveys there are certain data which always should be included; however, there is no intention of attempting to standardize the form of presentation. Though there are several methods which can be employed in the presentation of such data, the one preferred is a discussion of the separate areas or units followed by a consolidated table of data from all the units. The form of such tables will, of course, vary with the ideas of the reporting officer, but there are certain data which should always be shown regardless of what other information may be included. This information, which can be

secured from the strip data, will permit one who is not familiar with the area to visualize the situation and allow comparisons with other units or forests. To permit such visualization and comparisons the following information must be presented in the tables.

1. Total acreage of the area or unit to which the survey data is to be applied.

2. Acres of sample strip, or miles of strip of a stated width. With these data and the total acreage of the area, the percent covered can be determined easily, and could be included in the table if desired.

3. Infested trees counted on strip or the number of infested trees per acre of strip. The latter gives the best idea as to the intensity of the infestation, and is secured by dividing the total number of infested trees counted by the total number of acres covered. If desired, both the above items could be shown.

4. Total number of infested trees in the area or unit under consideration. Secured by multiplying the total acreage of the area by the number of infested trees per acre.

5. To show the results of control, or the increase or decrease of the infestation, the status of the outbreak of the previous season should be shown when available. When control measures have been conducted, the number of trees treated is essential information. It is not advisable to attempt to count both redtops and newly attacked trees while running strip, as errors are bound to occur. When areas are being surveyed for the first time, data for the previous season must be dispensed with and the status of the existing infestation be the deciding factor in determining the need for control.

6. A small scale map with the general location of the infested areas marked in colors with suitable legends should accompany the report.

7. The reporting officer's reaction to the advisability of instituting control is always of value. The "hot spots" of the area should be mentioned, as well as those portions of the total area which could be eliminated owing to light infestations.

CONCLUSIONS

It is trusted that these instructions will be of assistance to those charged with the important task of conducting an insect survey. Considerable detail has been employed, but it is still possible that there are still some explanations that have been omitted. The writer is anxious to be of any possible assistance and will be very glad to try and answer any questions which may be asked.

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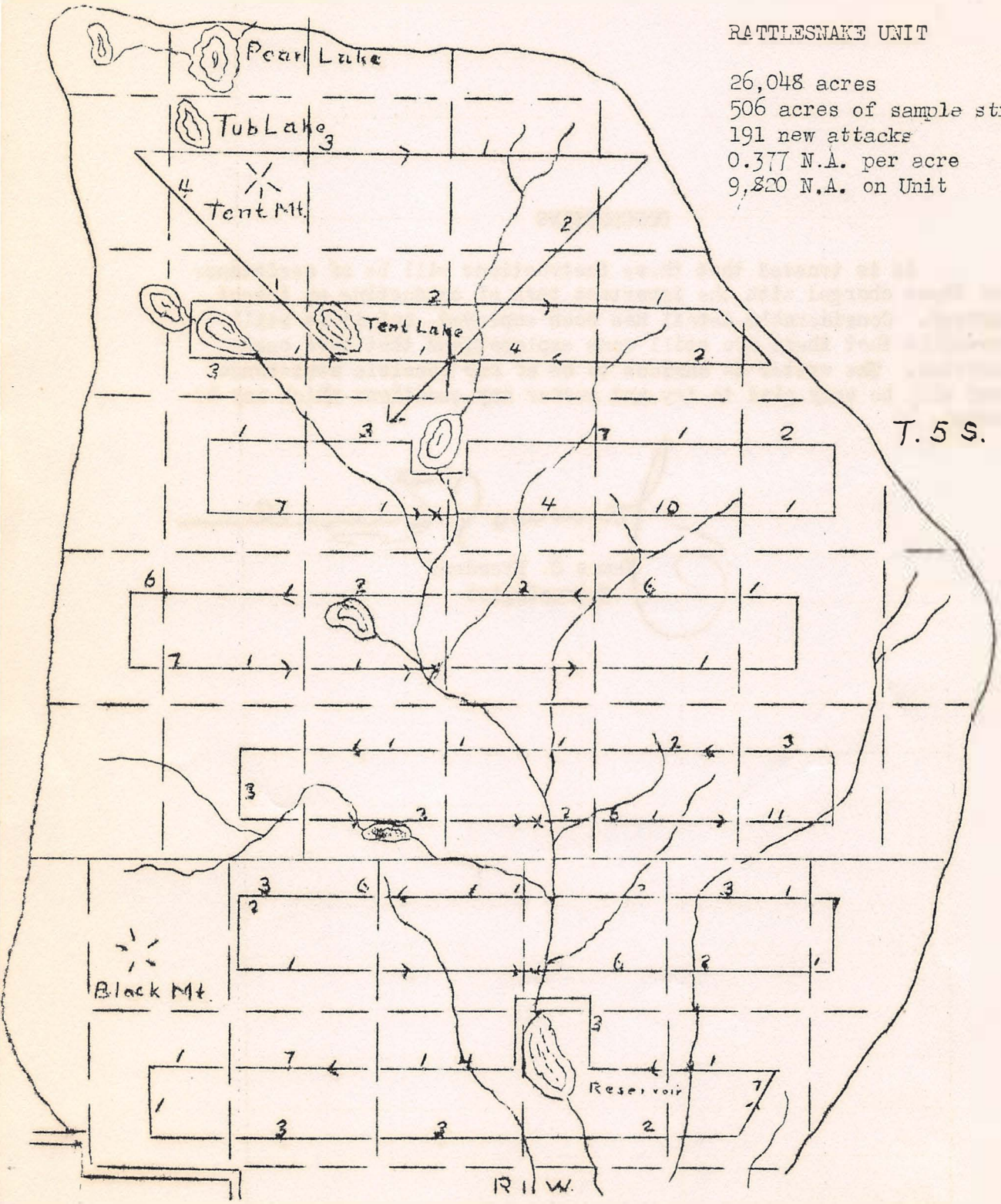

RATTLESNAKE UNIT

26,048 acres
506 acres of sample strip
191 new attacks
0.377 N.A. per acre
9,820 N.A. on Unit

Rattle Snake (Region) (Sheet No.) Sept. 21. 1933 (Date)

End of road at Tent Lake
(Starting Point)

John Doe
(Signature)

Bearing	Chains:	N.A.	L.P.P.:	Remarks
N. 45° W.	0 - 40	0		
	40-50	1		
	50-110	0		Old burn
	110-120	4		
	120-160	0		
East	0-100	0		Reprod.
	100-110	3		
	110-200	0		
	200-210	1		Mixed Fir & L.P.P.
	210-280	0		
S. 45° W.	0-50	0		Open park
	30-60	2		
	60-200	0		
Chains	640			
Acres	64			
New Attacks		11		
New attacks per acre			.172	